CLAIMS

What is claimed is:

1. A method of forming an air gap within a semiconductor structure comprising the steps of:

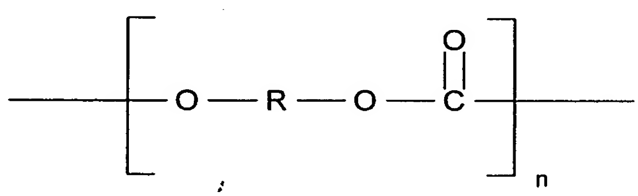
(i) using a sacrificial material to occupy a closed interior volume in a semiconductor structure;

(ii) causing the sacrificial material to decompose into one or more gaseous decomposition products; and

(iii) removing at least one of the one or more gaseous decomposition products by passage through at least one solid layer contiguous to the interior volume,

wherein the decomposition of the sacrificial material leaves an air gap at the closed interior volume previously occupied thereby, and the sacrificial material comprises a polymer composition selected from one or more polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

2. The method of claim 1, wherein the sacrificial material is a polycarbonate polymer comprises repeating units represented by the general formula of:



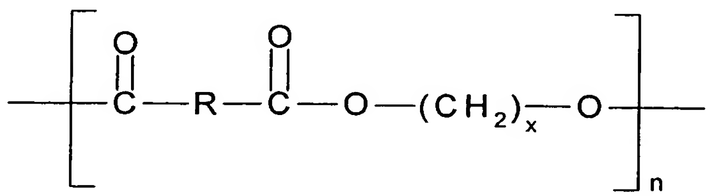
where R represents linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl and n is equal to 2 to about 100,000.

3. The method of claim 2, wherein n is equal to 2 to about 10,000.

4. The method of claim 2, wherein n is equal to 2 to about 1,000.

5. The method of claim 2, wherein the sacrificial material is selected from polyethylene carbonate, polyproplyene carbonate or a mixture thereof.

6. The method of claim 1, wherein the sacrificial material is a polyester polymer comprising repeating units represented by the general formula of:



where R represents linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl; x is an integer from 1 to about 20; and n is equal to 2 to about 100,000.

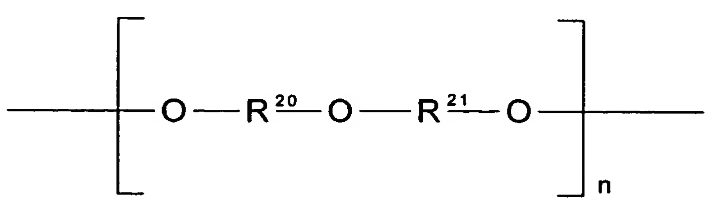
7. The method of claim 6, wherein n is equal to 2 to about 10,000.

8. The method of claim 6, wherein n is equal to 2 to about 1,000.

9. The method of claim 6, wherein x is an integer from 1 to about 10.

10. The method of claim 6, wherein x is an integer from 1 to about 6.

11. The method of claim 1, wherein the sacrificial material is a polyether polymer comprising repeating units represented by the general formula of:



where R^{20} and R^{21} independently represent linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl and n is equal to 2 to about 100,000.

12. The method of claim 11, wherein n is equal to 2 to about 10,000.

13. The method of claim 11, wherein n is equal to 2 to about 1,000.

14. The method of claim 1, wherein the sacrificial material is selected from a polymethyl methacrylate polymer, an acrylate polymer or a mixture thereof where the polymers present each have a molecular weight of about 1,000 to about 1,000,000.

15. The method of claim 14, wherein the polymethyl methacrylate and/or the acrylate polymer has a molecular weight of about 10,000 to about 500,000.

16. The method of claim 14, wherein the polymethyl methacrylate and/or the acrylate polymer has a molecular weight of about 100,000 to about 250,000.

17. A method of forming one or more air gaps in a semiconductor structure comprising the steps of:

(I) forming a patterned layer of sacrificial material on a substrate corresponding to a pattern of one or more gaps to be formed in the semiconductor structure;

(II) depositing a second material on the substrate within regions bordered by the sacrificial material;

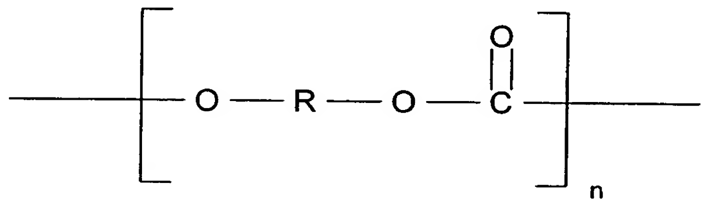
(III) forming an overcoat layer of material overlying the patterned layer of sacrificial material and second material in the regions bordered by the sacrificial material;

(IV) causing the sacrificial material to decompose into one or more gaseous decomposition products; and

(V) removing at least one of the one or more gaseous decomposition products by passage through the overcoat layer so that one or more air gaps are formed within the semiconductor structure,

wherein the sacrificial material is a polymer composition selected from one or more polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

18. The method of claim 17, wherein the sacrificial material is a polycarbonate polymer comprising repeating units represented by the general formula of:

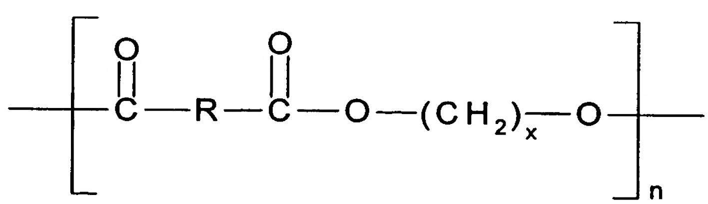


where R represents linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl and n is equal to 2 to about 100,000.

19. The method of claim 18, wherein n is equal to 2 to about 10,000.

20. The method of claim 18, wherein the sacrificial material is selected from polyethylene carbonate, polyproplyene carbonate or a mixture thereof.

21. The method of claim 17, wherein the sacrificial material is a polyester polymer comprising repeating units represented by the general formula of:



where R represents linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40})

aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl; x is an integer from 1 to about 20; and n is equal to 2 to about 100,000.

22. The method of claim 21, wherein n is equal to 2 to about 10,000.

23. The method of claim 21, wherein x is an integer from 1 to about 10.

24. The method of claim 17, wherein the sacrificial material is a polyether polymer comprising repeating units represented by the general formula of:

$$\left[-O-R^{20}-O-R^{21}-O- \right]_n$$

where R^{20} and R^{21} independently represent linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl and n is equal to 2 to about 100,000.

25. The method of claim 24, wherein n is equal to 2 to about 10,000.

26. The method of claim 17, wherein the sacrificial material is selected from a polymethyl methacrylate polymer, an acrylate polymer or a mixture thereof where the polymers present each have a molecular weight of about 1,000 to about 1,000,000.

27. The method of claim 26, wherein the polymethyl methacrylate and/or the acrylate polymer has a molecular weight of about 10,000 to about 500,000.

28. A semiconductor device having one or more air gaps therein produced in accordance with the method of claim 1.

29. A semiconductor device having at least one air gap therein comprising:

a substrate;

at least one conductive line or lead;

at least one air gap; and

an overcoat layer,

wherein the at least one air gap is produced in accordance with the method of claim 17.

30. The semiconductor device of claim 29, wherein the at least one air gap has a height which exceeds the height of an adjacent conductive line or lead.

31. A method of forming air gaps within a semiconductor structure comprising the steps of:

using at least one sacrificial material to occupy simultaneously or sequentially at least two closed interior volumes in a semiconductor structure, wherein the at least two closed interior volumes are on different levels of the semiconductor structure;

causing the at least one sacrificial material occupying the at least two closed interior volumes to decompose either simultaneously or sequentially into one or more gaseous decomposition products; and

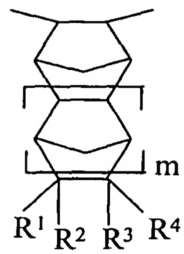
removing at least one of the one or more gaseous decomposition products by passage through at least one solid layer contiguous to the interior volume.

32. The method of claim 31, wherein the at least one sacrificial material is simultaneously decomposed into one or more gaseous decomposition products which are remove via passage through at least one solid layer contiguous to the interior volume.

33. The method of claim 32, wherein the at least one sacrificial material is selected from one or more norbornene polymers, polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

34. The method of claim 33, wherein the at least one sacrificial material is selected from one or more norbornene polymers.

35. The method of claim 34, wherein the norbornene polymer comprises repeating units of the general formula:



I

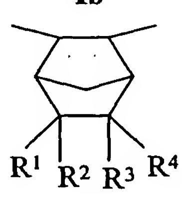
wherein R^1 and R^4 independently represent hydrogen or linear or branched (C_1 to C_{20}) alkyl; R^2 and R^3 independently represent hydrogen, linear or branched (C_1 to C_{20}) alkyl or the groups:

$$\begin{array}{l} \quad R^{9} \\ \quad | \\ -(CH)_n\text{-}SiR^{10}R^{11}R^{12} \end{array} \qquad \mathbf{Ia}$$

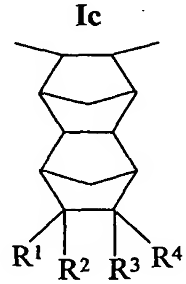
R^9 independently is hydrogen, methyl, or ethyl; R^{10}, R^{11}, and R^{12} independently represent linear or branched (C_1 to C_{20}) alkyl, linear or branched (C_1 to C_{20}) alkoxy, linear or branched (C_1 to C_{20}) alkyl carbonyloxy, and substituted or unsubstituted (C_6 to C_{20}) aryloxy; m is a number from 0 to 4; and n is a number from 0 to 5; and at least one of substituents R^2 and R^3 is selected from the silyl group represented by the formula set forth under **Ia**.

36. The method of claim 35, wherein in Formula **I** above, m is preferably 0 or 1 as represented by structures **Ib** and **Ic**, respectively:

Ib

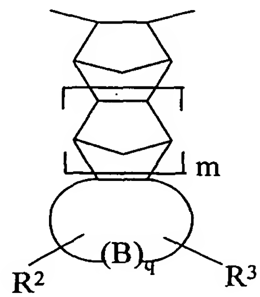


Ic



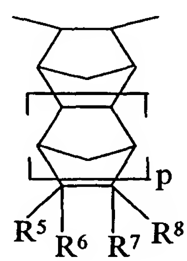
wherein R^1 to R^4 are as previously defined and at least one of R^2 and R^3 is a silyl substituent represented by **Ia**.

37. The method of claim 35, wherein R^1 and R^4 taken together with the two ring carbon atoms to which they are attached comprise a repeating unit of the following structure:



wherein B is a methylene group, q is a number from 2 to 6, and R^2 and R^3 are as defined above.

38. The method of claim 35, wherein the norbornene polymer further comprises hydrocarbyl substituted polycyclic repeating units selected from units represented by Formula **II** below:

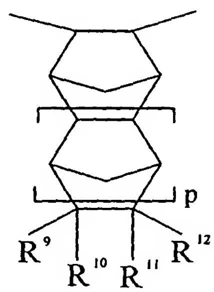


II

wherein R^5, R^6, R^7, and R^8 independently represent hydrogen, linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl, or vinyl; any of R^5 and R^6 or R^7 and R^8 can be taken together to form a (C_1 to C_{10}) alkylidenyl group, R^5

and R^8 when taken with the two ring carbon atoms to which they are attached can represent saturated and unsaturated cyclic groups containing 4 to 12 carbon atoms or an aromatic ring containing 6 to 17 carbon atoms; and p is 0, 1, 2, 3, or 4.

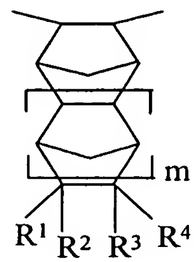
39. The semiconductor device as set forth in claim 34, wherein the norbornene polymer comprises repeating units represented by Formula **III** below:



III

wherein R^9 to R^{12} independently represent a polar substituent selected from the group: $-(A)_n-C(O)OR''$, $-(A)_n-OR''$, $-(A)_n-OC(O)R''$, $-(A)_n-OC(O)OR''$, $-(A)_n-C(O)R''$, $-(A)_n-OC(O)C(O)OR''$, $-(A)_n-O-A'-C(O)OR''$, $-(A)_n-OC(O)-A'-C(O)OR''$, $-(A)_n-C(O)O-A'-C(O)OR''$, $-(A)_n-C(O)-A'-OR''$, $-(A)_n-C(O)O-A'-OC(O)OR''$, $-(A)_n-C(O)O-A'-O-A'-C(O)OR''$, $-(A)_n-C(O)O-A'-OC(O)C(O)OR''$, $-(A)_n-C(R'')_2CH(R'')(C(O)OR'')$, and $-(A)_n-C(R'')_2CH(C(O)OR'')_2$; p is 0, 1, 2, 3, 4, or 5; the moieties A and A′ independently represent a divalent bridging or spacer group selected from divalent hydrocarbon groups, divalent cyclic hydrocarbon groups, divalent oxygen containing groups, and divalent cyclic ethers and cyclic diethers; and n is an integer 0 or 1.

40. The method of claim 34, wherein the norbornene polymer comprises copolymers comprising a combination of repeating units represented by Formulae **I** and **II**, Formulae **I** and **III**, Formulae **II** and **III** or Formulae **I**, **II** and **III**, where Formula **I** is:



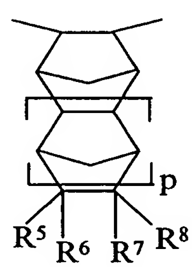
I

wherein R^1 and R^4 independently represent hydrogen or linear or branched (C_1 to C_{20}) alkyl; R^2 and R^3 independently represent hydrogen, linear or branched (C_1 to C_{20}) alkyl or the groups:

$$-(\overset{R^9}{\overset{|}{C}}H)_n-SiR^{10}R^{11}R^{12} \qquad \textbf{Ia}$$

R^9 independently is hydrogen, methyl, or ethyl; R^{10}, R^{11}, and R^{12} independently represent linear or branched (C_1 to C_{20}) alkyl, linear or branched (C_1 to C_{20}) alkoxy, linear or branched (C_1 to C_{20}) alkyl carbonyloxy, and substituted or unsubstituted (C_6 to C_{20}) aryloxy; m is a number from 0 to 4; and n is a number from 0 to 5; and at least one of substituents R^2 and R^3 is selected from the silyl group represented by the formula set forth under **Ia**;

Formula **II** is

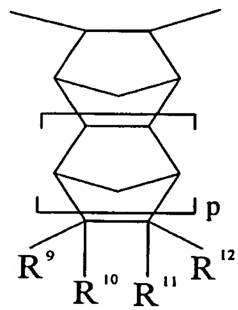


II

wherein R^5, R^6, R^7, and R^8 independently represent hydrogen, linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl, or vinyl; any of R^5 and R^6 or R^7 and R^8 can be taken together to form a (C_1 to C_{10}) alkylidenyl group, R^5

and R^8 when taken with the two ring carbon atoms to which they are attached can represent saturated and unsaturated cyclic groups containing 4 to 12 carbon atoms or an aromatic ring containing 6 to 17 carbon atoms; and p is 0, 1, 2, 3, or 4; and

Formula **III** is



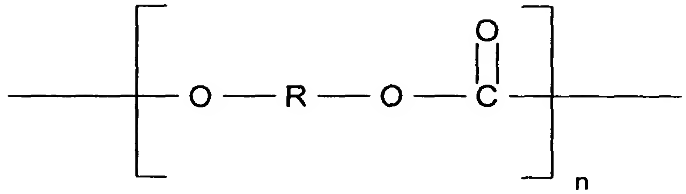
III

wherein R^9 to R^{12} independently represent a polar substituent selected from the group: $-(A)_n-C(O)OR''$, $-(A)_n-OR''$, $-(A)_n-OC(O)R''$, $-(A)_n-OC(O)OR''$, $-(A)_n-C(O)R''$, $-(A)_n-OC(O)C(O)OR''$, $-(A)_n-O-A'-C(O)OR''$, $-(A)_n-OC(O)-A'-C(O)OR''$, $-(A)_n-C(O)O-A'-C(O)OR''$, $-(A)_n-C(O)-A'-OR''$, $-(A)_n-C(O)O-A'-OC(O)OR''$, $-(A)_n-C(O)O-A'-O-A'-C(O)OR''$, $-(A)_n-C(O)O-A'-OC(O)C(O)OR''$, $-(A)_n-C(R'')_2CH(R'')(C(O)OR'')$, and $-(A)_n-C(R'')_2CH(C(O)OR'')_2$; p is 0, 1, 2, 3, 4, or 5; the moieties A and A′ independently represent a divalent bridging or spacer group selected from divalent hydrocarbon groups, divalent cyclic hydrocarbon groups, divalent oxygen containing groups, and divalent cyclic ethers and cyclic diethers; and n is an integer 0 or 1.

41. The method of claim 31, wherein the at least one sacrificial material is selected from one or more norbornene polymers.

42. The method of claim 31, wherein the at least one sacrificial material is selected from one or more polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

43. The method of claim 42, wherein the sacrificial material is a polycarbonate polymer comprises repeating units represented by the general formula of:

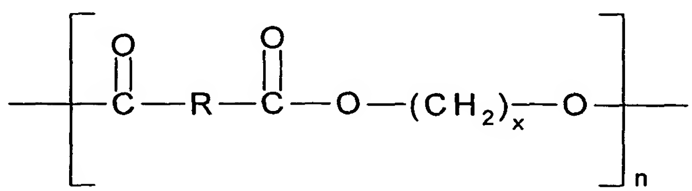


where R represents linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl and n is equal to 2 to about 100,000.

44. The method of claim 43, wherein n is equal to 2 to about 10,000.

45. The method of claim 43, wherein the sacrificial material is selected from polyethylene carbonate, polypropylyene carbonate or a mixture thereof.

46. The method of claim 42, wherein the sacrificial material is a polyester polymer comprising repeating units represented by the general formula of:



where R represents linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl; x is an integer from 1 to about 20; and n is equal to 2 to about 100,000.

47. The method of claim 46, wherein n is equal to 2 to about 10,000.

48. The method of claim 46, wherein x is an integer from 1 to about 10.

49. The method of claim 42, wherein the sacrificial material is a polyether polymer comprising repeating units represented by the general formula of:

$$-\!\!\!-\left[O-R^{20}-O-R^{21}-O \right]_n\!\!\!-\!\!\!-$$

where R^{20} and R^{21} independently represent linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl and n is equal to 2 to about 100,000.

50. The method of claim 49, wherein n is equal to 2 to about 10,000.

51. The method of claim 42, wherein the sacrificial material is selected from a polymethyl methacrylate polymer, an acrylate polymer or a mixture thereof where the polymers present each have a molecular weight of about 1,000 to about 1,000,000.

52. A semiconductor device having one or more air gaps therein produced in accordance with the method of claim 31.

53. A method of forming one or more air gaps in a semiconductor structure comprising the steps of:

(A) forming a patterned layer of a first sacrificial material on one side of a substrate corresponding to a pattern of one or more gaps to be formed in the semiconductor structure;

(B) depositing a second material on the substrate within regions bordered by the first sacrificial material;

(C) forming a first overcoat layer of material overlying the patterned layer of the first sacrificial material and the second material in the regions bordered by the first sacrificial material;

(D) causing the first sacrificial material to decompose into one or more gaseous decomposition products;

(E) removing at least one of the one or more gaseous decomposition products by passage through the first overcoat layer so that one or more air gaps are formed within the semiconductor structure;

(F) forming a patterned layer of a second sacrificial material on the first overcoat layer corresponding to a pattern of one or more gaps to be formed in the semiconductor structure;

(G) depositing a third material on the first overcoat layer substrate within regions bordered by the second sacrificial material;

(H) forming a second overcoat layer of material overlying the patterned layer of the second sacrificial material and the third material in the regions bordered by the second sacrificial material;

(I) causing the second sacrificial material to decompose into one or more gaseous decomposition products; and

(J) removing at least one of the one or more gaseous decomposition products by passage through the overcoat layers so that one or more air gaps are formed within the semiconductor structure,

wherein the first and second sacrificial materials are independently selected from one or more polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

54. A method of forming one or more air gaps in a semiconductor structure comprising the steps of:

(A) forming a patterned layer of a first sacrificial material on one side of a substrate corresponding to a pattern of one or more gaps to be formed in the semiconductor structure;

(B) depositing a second material on the substrate within regions bordered by the first sacrificial material;

(C-1) forming a first overcoat layer of material overlying the patterned layer of the first sacrificial material and the second material in the regions bordered by the first sacrificial material;

(C-2) forming a patterned layer of a second sacrificial material on the first overcoat layer corresponding to a pattern of one or more gaps to be formed in the semiconductor structure;

(C-3) depositing a third material on the first overcoat layer within regions bordered by the second sacrificial material;

(C-4) forming a second overcoat layer of material overlying the patterned layer of the second sacrificial material and the third material in the regions bordered by the second sacrificial material;

(D') causing the first and second sacrificial materials to decompose into one or more gaseous decomposition products; and

(E') removing at least one of the one or more gaseous decomposition products by passage through the overcoat layers so that one or more air gaps are formed within the semiconductor structure,

wherein the first and second sacrificial materials are independently selected from one or more norbornene polymers, polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

55. A method of forming one or more air gaps in a semiconductor structure comprising the steps of:

using a sacrificial material to occupy at least one first closed interior volume in a semiconductor structure and using a conductive material to occupy at least one second closed interior volume in a semiconductor structure, the at least one first closed interior volume and the at least one second closed interior volume defining at least one gap therebetween;

forming an overcoat layer of material on the sacrificial material and the conductive material with the overcoat material extending into the at least one gap;

causing the sacrificial material to decompose into one or more gaseous decomposition products; and

removing at least one of the one or more gaseous decomposition products by passage through the first overcoat layer so that one or more air gaps are formed within the semiconductor structure, thereby yielding overcoated conductive structures.

56. The method of claim 55, wherein the overcoat material completely fills the one or more gaps between the sacrificial material and the conductive material.

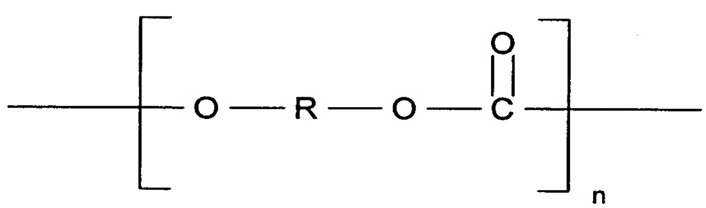
57. The method of claim 55, wherein the sacrificial material is selected from one or more norbornene polymers, polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

58. The method of claim 57, wherein the sacrificial material is selected from one or more norbornene polymers.

59. The method of claim 55, wherein the height of the at least one first closed interior volume exceeds the height of the at least one second closed interior volume.

60. The method of claim 55, wherein the height of the at least one second closed interior volume exceeds the height of the at least one first closed interior volume.

61. The method of claim 55, wherein the sacrificial material is a polycarbonate polymer comprises repeating units represented by the general formula of:



where R represents linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl and n is equal to 2 to about 100,000.

62. The method of claim 61, wherein n is equal to 2 to about 10,000.

63. The method of claim 61, wherein the sacrificial material is selected from polyethylene carbonate, polyproplyene carbonate or a mixture thereof.

64. The method of claim 55, wherein the sacrificial material is a polyester polymer comprises repeating units represented by the general formula of:

$$\left[-\overset{\overset{\displaystyle O}{\|}}{C}-R-\overset{\overset{\displaystyle O}{\|}}{C}-O-(CH_2)_x-O- \right]_n$$

where R represents linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl; x is an integer from 1 to about 20; and n is equal to 2 to about 100,000.

65. The method of claim 64, wherein n is equal to 2 to about 10,000.

66. The method of claim 64, wherein x is an integer from 1 to about 10.

67. The method of claim 55, wherein the sacrificial material is a polyether polymer comprises repeating units represented by the general formula of:

$$\left[-O-R^{20}-O-R^{21}-O- \right]_n$$

where R^{20} and R^{21} independently represent linear and branched (C_1 to C_{20}) alkyl, hydrocarbyl substituted and unsubstituted (C_5 to C_{12}) cycloalkyl, hydrocarbyl substituted and unsubstituted (C_6 to C_{40}) aryl, hydrocarbyl substituted and unsubstituted (C_7 to C_{15}) aralkyl, (C_3 to C_{20}) alkynyl, linear and branched (C_3 to C_{20}) alkenyl and n is equal to 2 to about 100,000.

68. The method of claim 67, wherein n is equal to 2 to about 10,000.

69. The method of claim 55, wherein the sacrificial material is selected from a polymethyl methacrylate, an acrylate polymer or a mixture thereof where the polymers present each have a molecular weight of about 1,000 to about 1,000,000.

70. The method of claim 69, wherein the polymethyl methacrylate and/or the acrylate polymer has a molecular weight of about 100,000 to about 250,000.

71. A semiconductor device having one or more air gaps therein produced in accordance with the method of claim 55.

72. A semiconductor structure comprising:

a substrate;

a sacrificial material supported on the substrate;

a conductive material supported on the substrate and spaced apart from the sacrificial material;

an overcoat layer overcoating the sacrificial material and the conductive material and extending into the one or more spaces between the sacrificial material and the conductive material.

73. The semiconductor structure of claim 72, wherein the sacrificial material is selected from one or more norbornene polymers, polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

74. The semiconductor structure of claim 72, wherein the height of the sacrificial material exceeds the height of the conductive material.

75. The semiconductor structure of claim 72, wherein the height of the conductive material exceeds the height of the sacrificial material.

76. A semiconductor structure comprising:

a substrate;

a sacrificial material supported on the substrate;

a conductive material supported on the substrate and spaced apart from the sacrificial material;

an overcoat layer overcoating the sacrificial material and the conductive material and extending into the one or more spaces between the sacrificial material and the conductive material,

wherein the sacrificial material has been removed by decomposition through the overcoat layer.

77. The semiconductor structure of claim 76, wherein the sacrificial material is selected from one or more norbornene polymers, polycarbonate polymers, polyester polymers, polyether polymers, methacrylate polymers, acrylate polymers, or mixtures thereof.

78. The semiconductor structure of claim 76, wherein the overcoat material of the overcoat layer completely fills the one or more gaps between the sacrificial material and the conductive material.

79. The semiconductor structure of claim 76, wherein the height of the sacrificial material exceeds the height of the conductive material.

80. The semiconductor structure of claim 76, wherein the height of the conductive material exceeds the height of the sacrificial material.